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NOTES ON THE GEOLOGY OF RADNOR AND VICINITY.

BY THEO. D. RAND.

There has recently been published in the Proceedings of the American Philosophical Society (January to March, 1880; vol. xviii, No. 105) a paper read before the Society, January 2, 1880, by Charles E. Hall, on the Relations of the Crystalline Rocks of Eastern Pennsylvania, some of the conclusions in which so differ from my own observations that a statement of the latter may not be without interest, especially as regards the middle serpentine belt in Radnor, which I have been studying for some time.

Mr. Hall describes seven series of rocks and two serpentine horizons. Of these I have carefully examined but the second, fifth and seventh series and the serpentines. The second, he describes as "A series of syenitic, hornblendic and quartzose rocks, extending westward from Chestnut Hill, and covering a greater part of the northern portion of Delaware County."

These rocks, locally known in Delaware County as "Radnor Rocks," from their prevalence in that township, are in abundant outcrops in very many places, perhaps the most remarkable of which is a hill in the form of a truncated cone, perhaps 400×800 feet on the summit, with steep but not precipitous sides, 80 to 100 feet in height, situated in Chester County nearly south from Reeseville, and a prominent object in the landscape. North of these rocks occur those called by Prof. Rogers in the Geology of Pennsylvania, vol. 2, p. 72, primal older slates, and well described by him as follows:

"Metamorphosed with characteristic white streaks of imperfectly crystallized feldspar, and dark hornblendic material, with roundish specks of semicrystallized feldspar."

They are in fact gneiss, composed generally of thin layers of most varied character, feldspar being abundant, mica, hornblende and quartz varying in the layers from almost nothing to great abundance of one or the other; and many of these layers often appearing in an inch, giving at times a schistose character to the rock, but the mica or hornblende never so abundant that it can

properly be called schist. The minerals composing this rock closely resemble those of the gneiss on the south; so close is the resemblance of certain strata in the one, to some of the other, the difference being chiefly in mode of aggregation, that it seems to me not improbable that the northern are but upper strata of the southern gneiss.

The fifth group of Mr. Hall is described as "Hydromica schists, quartzose schists, chloritic schists and occasional beds of quartzite and sandy beds, and serpentines," of which he says, page 436: "These are the Hudson River shales and flank the Chester Valley on the south * * * the entire length of the Valley. They extend south to the syenitic rocks of the second group." Mr. Hall does not mention the schistose gneiss, nor is it possible to include it under his description of either the second or fifth groups which he places in contact. On page 441 he says: "The serpentines of Radnor Township, Delaware County, and those of eastern Willistown, east and west Goshen, are undoubtedly altered beds of the South Valley Hill slates or Hudson River slates. They lie unconformably upon the syenitic rocks of the second group." There are, as I have heretofore shown (Proceedings Acad. Nat. Sci., Philada., Nov., 1878), three approximately parallel beds of serpentine in Radnor Township. Presuming, as seems from the connection with the Chester County outcrops, that the middle and most conspicuous belt is intended, I cannot agree with Mr. Hall in his conclusions.

This middle belt is the largest of the three, and north of the syenite hill appears first on the Mattson's Ford or township line road, on the westerly side of a small affluent of the Gulf Creek, one-quarter mile northeast of Radnor Station, with a strike nearly E. and W. The serpentine forms a large hill, which begins abruptly and closely resembles in lithological character that of the Lafayette or Rose's quarry belt. The next or second outcrop is nearly west of this and is inconspicuous. The third, northwest of Radnor Station, is about 1000 feet in length. Its centre is nearly due west from the first; the strike is not far from N. 60 E. This outcrop ends abruptly. About 400 feet north is a small outcrop appearing as if the end of the ridge had been removed 400 feet northward. Beyond this I believe no outcrops have been described until we reach those near Paoli, but several exist: the fifth, nearly S. from Eagle Station, small and the strike indistinct;

the sixth, S. W. of Eagle, is S. 70° W. from the fifth, with a strike S. 40° W., dip about 75° to 80° S.; the seventh is nearly due W. from the fourth, its strike N. 50° to 60° E.; the eighth is a little S. of W. of the seventh, strike and dip not distinct; the ninth, that crossing the road running S. E. from Berwyn, and about a mile from that station, is at its eastern end S. 10° W. from the eighth, its strike is S. 40° W. The outcrop near Paoli is nearly W. from this, and extends thence as the wide and well-known belt passing one mile north of West Chester.

Now, examining the first outcrop, that on the Mattson's Ford road, we find on the S. the rocks of group one without doubt, but on the N. we find almost identical rocks—hornblende gneiss, porphyritic gneiss and feldspathic gneiss. It is difficult to conceive that *these* are altered Hudson River shales. Beyond them are the primal older slates of Prof. Rogers, before referred to, then the northerly belt of serpentine, then gneiss, and occasionally (to the westward frequently) garnetiferous mica schist, then limestone, then trap, and then, fully one-quarter of a mile from the serpentine, the schistose rocks of the South Valley Hill, agreeing accurately with Mr. Hall's description of the fifth group. These intermediate beds thin out westwardly, until the serpentine, the trap and the hydromica schists of the South Valley Hill appear to come in contact.

The strike of the trap and of the southerly border of the schists, with which, in Radnor, it appears in contact, separating them from the primal older slates, being about S. 70° W., the serpentine and the schists are much closer at the western end of the Radnor Station outcrops, the intermediate strata thinning out as stated, and the serpentine perhaps crossing them in part; but even here, there is at least 800 feet of the schistose gneiss between them, with some garnetiferous mica schist, which seems to continue in a narrow belt close to the trap to near Paoli.

It will be noticed on the map accompanying Prof. Hall's paper, that this serpentine belt is made continuous from near West Chester into Delaware County in a straight line, except at the eastern end, where a marked southerly curve occurs near the line of Montgomery County, carrying the serpentine well into the rocks of group one. If my observations are correct, this line should be a series of disjointed lines, the easterly end of each more northerly than the westerly end of the succeeding; but, in

any event, if the map is correct as to the eastern extremity, the text is not so.

Mr. Hall's seventh series, page 436, is "The mica schists of Philadelphia * * * talcose schists, with soapstone and serpentine. They rest unconformably upon the first, second, third and fourth groups. * * * There are, besides these groups, probably two serpentine horizons, which are undoubtedly unconformable deposits above the second group. I think the northern belt of serpentine may be considered as altered Hudson River rock, while the southern belts are doubtful."

Page 441-442: "Dr. T. Sterry Hunt insists that the serpentines of the Schuylkill are below the Philadelphia schists. * * * At present I am inclined to place these serpentines above the Philadelphia rocks, and by so doing assign the Philadelphia series to a higher group than the Hudson River. * * * To all appearances the serpentine belts which are visible on the Schuylkill River at Lafayette Station, Montgomery County, and at a point just north of them, are above the mica schists of Philadelphia. The southern belt extends in an almost unbroken line from Chestnut Hill, Philadelphia, to Bryn Mawr, Montgomery County. A less prominent belt extends from the Schuylkill River to the neighborhood of Rosemont Station, on the Pennsylvania Railroad, in a parallel line to the first belt."

The meaning of the author in the two opinions first quoted, from pages 441-442, is not altogether clear. If there is dependence to be placed on lithological characteristics, the southern or soapstone belt continues far to the southwestward; as to it, I believe, belong the outcrops on Meadow Run, on both sides of Darby Creek, near Moro Phillips' chrome-mine, in Radnor Township; thence southwestwardly continuously through Newtown and Marple Townships. In this belt there is one rock described by me many years ago characteristic of it, and, so far as my knowledge extends, confined to it (except outcrop at Rosemont hereafter referred to) a steatite filled with crystals of serpentine pseudomorphous after staurolite. This rock is very abundant and prominent from Chestnut Hill to a point a short distance west of Mill Creek, and is found also, but not abundantly, west of Darby Creek. The northeasterly portion of this belt contains very little serpentine; steatite and chlorite constitute the greater part of its mass. Its strike is about S. 52° W., its bounding

rock is the well-known wood-like garnetiferous schist; partially altered rocks found at the soapstone quarry on the Schuylkill seem to show that it has arisen from the pseudomorphism or metamorphism of interstratified hornblendic and micaceous gneiss and schists. It contains quite a number of minerals. The northerly belt, on the contrary, is little else than a very dark, almost black serpentine; except chrysotile and asbestos, and some talc and chlorite, it is almost destitute of minerals, and at Rose's quarry has undoubtedly been formed, not from Hudson River shales, but from a hard, compact enstatitic rock visible there in place, and this rock appears to be unstratified. It extends from the Schuylkill S. 59° W. $1\frac{1}{2}$ miles to a point on Barr's farm, where, as a hill, it suddenly ends, but it may be traced by fragments to an outcrop in the Conshohocken road, near the house of William Schalliol, and to the south of the former line of strike. Thence it crosses the road to Bryn Mawr east of a small stream, with a course about S. 35° to 40° W., and after crossing seems to curve even more southwardly, but this is on a hillside and is probably due to creep. About 400 yards beyond, in the same direction, fragments are abundant in a field. Through this portion the rock on the north appears to be a very thin bedded compact gneiss, with two, and often three, easy cleavages, together with a peculiar schistose feldspathic gneiss, in which the mica is in small masses or isolated crystals, generally with curved surfaces, remaining brilliant on exposure. On the south the rock is a schist, micaceous or chloritic, but garnets are almost and perhaps wholly absent. North of this about 250 feet, just at the crossing of two roads, is an outcrop of serpentinous rock, or a hornblendic rock partially altered to serpentine, very different from that in the southerly outcrop, and about 1400 feet S. 60° W. a similar rock appears in quantity forming a small hill. East of the Gulf road, and about S. 43° W. from the last, fragments are found in the soil. West of the Gulf road is a conspicuous bluff of serpentine dipping southwardly, and S. 45° W. an outcrop at Rosemont Station, where it has been quarried. At this point the rock resembles that of the soapstone belt, and is wholly unlike that of any other part of this, which elsewhere closely resembles that near Radnor Station.

Mr. Hall makes no mention of the Potsdam sandstone on the south side of the Chester Valley, further than in his fifth group mentioning sandy beds.

Finding, as we do, as has been described by Mr. H. C. Lewis and myself, extensive deposits along the base of the South Valley Hill, not only of a remarkably white sand, but of large masses of compact sandstone, very closely resembling that of the North Valley Hill, and the same rock, much decomposed, being found in the valley south of the South Valley Hill, accompanied by iron ore as at other places, and finding it nowhere else in the very great exposure of the hydromica schist rock of the South Valley Hill, it would seem more likely to be the Potsdam found in the same position east of the Schuylkill than mere accidental beds of sandstone, intercalated in the schists just at those points.

A trap-dyke has been referred to as lying between the hydromica schists of the South Valley Hill and the rocks on the south of it. This is prominent from the Schuylkill for about three and one-half miles to the farm of Mr. Frank Fennimore, near Wayne Station. Here it appears to widen out, and perhaps to divide into two branches, one crossing the railroad and turnpike between Wayne and Eagle, and being very prominent south and southwest of Eagle store, with a strike approximating S. 60° W. and completely within the gneiss; the other branch, or a distinct dyke, accompanying the serpentine in a more nearly due west direction. A mile southeast of Berwyn, the latter can be seen almost if not quite in contact with the serpentine, the trap, however, being on the *south* of the serpentine. The same is true south of Paoli, except that the trap appears to be on the north side. Prof. Rogers, page 168, speaks of this trap as "occurring along and outside the northern edge of the serpentine, in a succession of narrow elongated dykes, ranging more N. E. and S. W. than the serpentine." These I have not examined, but such structure agrees precisely with what I have observed of the serpentine further east.

South of the serpentine, perhaps from a bed in the Radnor gneiss, occur in the fields, often abundantly, a white quartz, weathering yellow on the surface, except certain portions which remain white. The form of many of these seems to forbid the idea of mere accident, and to suggest that they may be due to the remains of organic material which have deoxidized the contained iron, and thus facilitated its removal.

Note on Damourite from Berks Co., Penna.—MR. F. A. GENTH, JR., remarked that a short time ago Mr. H. W. Hollenbush, of